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PATENT SPECIFICATION

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PROVISIONAL SPECIFICATION

Improvements in or relating to Liquid Damped Shock Absorbers

We, THE RIBBESFORD COMPANY LIMITED, a British Company, of Tachbrook Road, Leamington Spa, in the County of Warwick, and PETER WARBORN THORNHILL, a British Subject, of the Company's address, do hereby declare the nature of this invention to be as follows:—

This invention relates to liquid damped shock absorbers, and has for its primary object to provide a simple and effective shock absorber. Another object is to provide a telescopic shock absorber comprising a plunger adapted to reciprocate in a cylinder in which telescopic movement can be prevented by closing the liquid transfer passage through the plunger.

According to the invention, the shock absorber comprises a cylinder having a liquid-containing space divided into two chambers by a plunger head mounted on a stem extending through one end of the cylinder, an orifice or orifices being formed in the plunger head to permit controlled flow of liquid from one chamber to the other, and a resiliently loaded floating piston forming one end wall of the liquid containing space.

The resiliently loaded floating piston is preferably of annular form and surrounds the plunger stem. The resilient loading of the piston may be provided by a plurality of Belleville washers.

The liquid transfer passage or passages in the plunger head are preferably adapted to be closed by means operable from the outer end of the plunger stem, said means comprising for example a rod movable axially in the plunger stem and having at its inner end a closure element to close the passage or passages.

In one form of shock absorber according to the invention, which is hereinafter described by way of example, a length of tubing forming the cylinder is provided at one end with a cap welded on and formed with a central threaded spigot projecting axially to form an attachment for the shock absorber. A plunger head slidable in the cylinder, and provided with packing means to ensure that it is a fluid-tight fit in the cylinder, is formed integral with a stem of considerably smaller diameter than the cylinder, the stem passing through a central aperture in a second end cap screwed on to the open end of the cylinder. An annular floating piston is mounted in the cylinder around the plunger stem, and is urged inwardly of the cylinder by a stack of Belleville washers arranged between the floating piston and the screwed end cap of the cylinder.

The plunger is formed with a central recess on its face opposite to that from which the stem projects, and from the inner part of this recess a plurality of passages open to the annular face of the plunger surrounding the stem. The wall of the recess is threaded to receive a plug screwed thereinto, the plug being centrally apertured and counterbored from its inner side to provide a valve seat. A valve member having a frusto-conical seating face is urged on to the said seat by a coil spring taking its abutment on the base of the recess, the valve member being itself provided with a central aperture which is of uniform diameter from the seating end of the valve member for about three-quarters of its length, the remaining part being flared outwardly. Into this aperture projects a metering pin, mounted as described below. The plunger stem is hollow, and through it extends a rod in which is formed an annular groove near its inner end to receive a sealing ring. The metering pin is mounted on the inner end of this rod. To the outer end of the rod is secured a cap which is internally threaded to engage a screw thread on the external surface of the plunger stem, the thread being extended along the stem to receive two nuts for clamping the stem to a mounting bracket. The inner end of the rod is adapted to mate with the outwardly flared end of the aperture in the valve member, to close the said aperture and hold the valve member firmly on to its seat.

The shock absorber is filled with liquid by extending it to the maximum possible extent, removing the rod, and pouring liquid through the hollow stem. The rod is then replaced and screwed in far enough to cause the metering pin to enter

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the uniform diameter part of the aperture through the valve member, but leaving the valve free to lift. This position is preferably indicated by a resilient arm clamped under the outer fixing nut for the stem, and bent upwardly and inwardly to engage a projecting collar on the cap secured to the end of the rod. The spring loading of the valve member is such that it does not lift under the pressures normally encountered, so that the damping is governed by the relative diameters of the aperture in the valve member, and the metering pin. The valve can, however, open if an exceptionally great compressive force is applied to the shock absorber, to allow a greater passage for the flow of liquid. When the shock absorber is compressed, the plunger stem occupies a greater volume of the space in the cylinder, the liquid displaced being accommodated by compression of the Belleville washers and resultant movement of the floating piston. The Belleville washers also serve to cushion the recoil of the shock absorber when it reaches the end of its normal extension stroke.

By screwing the rod inwardly until its inner end seats in the flared end of the aperture in the valve member, and holds the valve member on to its seat, the passage of liquid from one side of the piston to the other is prevented, and the shock absorber becomes in effect an incompressible strut of fixed length.

The particular form of shock absorber described is primarily intended for mounting within a coil spring forming the resilient suspension of a gun carriage, the tripping of the liquid to prevent movement of the shock absorber plunger in the cylinder being used to prevent the shock absorber from operating when the gun is in action. It is obvious that the shock absorber may be modified for other uses, such as the suspension of road or other vehicles.

Dated this 8th day of January, 1943.
For the Applicants,
F. J. CLEVELAND & COMPANY,
Chartered Patent Agents,
29, Southampton Buildings,
Chancery Lane, London, W.C.2.

COMPLETE SPECIFICATION

Improvements in or relating to Liquid Damped Shock Absorbers

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This invention relates to liquid damped shock absorbers, and has for its primary object to provide a simple and effective shock absorber. Another object is to provide a telescopic shock absorber comprising a plunger adapted to reciprocate in a cylinder in which telescopic movement can readily be prevented, when required, by closing the liquid transfer passages through the plunger.

In a liquid damped shock absorber having a cylinder, a damping piston dividing the interior thereof into two liquid-filled working spaces, damping means in the piston affording a restricted communication between said working spaces, a piston rod extending from the damping piston through an end wall of the cylinder to constitute one of the external attachment means of the device, and a floating piston mounted slidably in the cylinder, to form a boundary wall for one of said working spaces and so compensate for the variable displacement of the piston rod, the present invention is characterised by the fact that the damping means in the piston is adjustable from the exterior of the shock absorber by a member extending longitudinally through the piston rod and having operating means accessible from the outside of the shock absorber.

Preferably the damping means in the piston includes a constriction the size of which is adjustable by the member extending longitudinally through the piston rod. The adjusting member can comprise a longitudinal rod extending through an axial bore in the piston rod and arranged to be adjusted axially by means of a screw-thread. In the preferred arrangement, the constriction is produced by a pin which is carried by the inner end of the longitudinal rod and is normally disposed within a passage in the damping piston so as to produce in said passage a constriction of narrow annular cross-section for the flow of liquid from one side of the damping piston to the other.

The invention is illustrated by way of example in the accompanying drawing, which is a sectional elevation of a shock absorber installed in conjunction with a suspension spring of the helical compression type.

This suspension spring is indicated at 10 and is arranged to operate between an upper fixing bracket 11 secured to the vehicle frame or body, while the lower part of the spring 10 is housed within a cup-shaped bracket 12 carried by the wheel axle or equivalent.

The shock absorbing unit comprises a cylinder 13, which is closed at its lower end by a cap 14, having an integral spigot 15 serving, in conjunction with a nut 16, to clamp the cylinder 13 to the bracket 12. The upper end of the cylinder 13 is fitted with a cap 17 by means of a screw-thread 18, said cap being formed with a central aperture through which a tubular piston rod 19 is freely slidable, the upper end of said piston rod being screw-threaded at 20 and being provided with nuts 21 and 22 serving to clamp said rod to the upper bracket 11. An inverted cup-shaped dust shield 23 is also clamped by the nut 21 and its skirt portion extends downwards around the cylinder 13 so as to protect the piston rod 19 from dirt, water and other foreign matter.

Formed upon the lower end of the piston rod 19 is a damping piston, having a circumferential groove containing a packing ring 25 so as to enable said piston 24 to have a substantially liquid-tight sliding fit within the cylinder 13. The piston 24 thus divides the interior of the cylinder 13 into two variable volume working spaces, indicated at 26 and 27. Said piston 24 is shaped with a substantially cylindrical recess 28, communicating freely with the working space 26 by way of a plurality of oblique passages 29, while the lower part of said recess is partially closed by an annular seating member 30 screw-threaded in position and provided with a washer 31 so as to produce a liquid-tight joint between the seating member 30 and the piston 24. This seating member has an inwardly directed circumferential flange 32, the upper edge of which is adapted to form a seating for a mushroom-shape by-pass valve member 33, the head portion of which has a frusto-conical face or seating 34. The by-pass valve member 33 is urged against the flange 32 by a relatively strong coiled compression spring 35, taking abutment against the upper surface of the recess 28. The stem portion 36 of the valve member 33 is drilled axially at 37, so producing a passage which communicates between the working spaces 26 and 27. This passage is, however, constricted to provide the requisite damping effect by a pin 38, screw-threaded into the lower end of a longitudinal rod 39 fitting slidably within the tubular piston rod 19. In order to secure a liquid-tight fit between these parts the rod 39 has a circumferential groove adjacent its lower end for the accommodation of a rubber or other resilient packing ring 40.

The pin 38 is arranged to be axially adjusted relative to the valve member 33 and for this purpose the upper end of the rod 39 is fixed to a cup-shaped nut 41, which latter is screw-threaded upon the top part of the piston rod 19 and is provided with a knurled flange 42 to serve as a finger-operated adjustment. Axial adjusting movement of the nut 41 is limited by a pointer 43, which, however, is sufficiently resilient to be deflected outwards when it is desired to remove the nut 41 and rod 39 from the shock absorber.

At the upper part of the cylinder 13 is a floating piston, which is indicated generally at 44, and is arranged to serve as a boundary wall for the variable volume working space 26. The floating piston 44 comprises a washer 45 of resilient material such as rubber, which washer is a tight sliding fit within the cylinder 13 and is provided with metal reinforcing plates 46 and 47, clamped together in spaced relationship by rivetted studs 48. The plate 47 is formed with a tubular extension 49 and this serves as a support for a number of wear-resisting rings 50, having a sliding liquid-tight fit upon the outside of the piston rod 19. Thus the floating piston 44 serves as a liquid-tight packing between the piston rod 19 and the interior of the cylinder 13. Between the upper surface of the floating piston 44 and the interior of the cap 17 is a compression spring 51, conveniently comprising a plurality of dished or Belleville washers 52 arranged alternately so as to produce a W-formation, as seen in radial section. It will, of course, be appreciated that when outward force is exerted by the floating piston 44 the washers 52 are resiliently deformed to a more flattened condition and thus act in the same manner as a coiled compression spring. The uppermost of the washers 52 abuts against a thick annular support washer 53 disposed within the cap 17.

After assembly, the shock absorber is filled with liquid by withdrawing the piston rod 19 to the maximum possible extent from the cylinder 13, thus drawing the damping piston 24 into firm contact with the floating piston 44. The nut 41 is unscrewed from the piston rod 19, the pointer 43 being sprung to one side in order to allow said nut 41 and the rod 39 to be withdrawn completely from the piston rod 19. This leaves the bore of the piston rod 19 free and liquid is poured in through said bore until the interior of the shock absorber is completely full of

liquid. The rod 39 is then replaced and the nut 41 screwed upon the piston rod 19 to approximately the position shown in the drawing. The pin 38 is consequently positioned just within the passage 37 of the by-pass valve 33, thus leaving between said pin and the passage 37 a constriction which in cross-section is in the form of a narrow annulus. Therefore as the bracket 12 tends to move up and down relative to the bracket 11 liquid has to pass to and fro through the constricted passage 37, due to movements of the damping piston 24 relative to the cylinder 13. This, of course, damps the movement and enables smooth riding of the vehicle to be obtained. The degree to which the passage 37 is constricted can be regulated from the outside of the shock absorber by suitably adjusting the postion of the nut 41. Should the bracket 12 receive a severe impulse in an upward direction, the consequent excessive rise in liquid pressure within the working space 27 creates upon the by-pass valve member 33 an upward force which is able to overcome the compression spring 35, so that said by-pass valve is opened and liquid can readily escape from the working space 27 by flowing between the face 34 of the valve member and the seating on the flange 32. Excessively powerful movements of the cylinder 13 in a downward direction merely cause the pressure liquid within the working space 26 to act strongly in an upward direction upon the floating piston 44, thus compressing the spring 51 and so avoiding damage to the shock absorber. The floating piston 44 and spring 51 also serve to accommodate the variations in the pressure of the damping liquid within the cylinder 13 owing to the variable displacement of the piston rod 19, the floating piston 44 rising against the spring 51 as the piston rod 19 moves downwards within the cylinder 13. Moreover, the spring 51 also serves to cushion the recoil of the shock absorber when the damping piston 24 comes into engagement with the floating piston 44 towards the end of a full extension stroke.

In certain circumstances it may be desirable to use the shock absorber as a hydraulic locking device between the brackets 11 and 12, and to produce this effect the nut 41 is screwed downwards upon the piston rod 19 so that the longitudinal rod 39 bears at its lower end against a countersunk frusto-conical surface 54 at the end of the stem 36 of the by-pass valve 33. It will be seen that this not only closes the passage 37 completely but also forcibly holds the by-pass valve member 33 in seating engagement with the flange 32; therefore all communication between the working spaces 26 and 27 is cut off and the liquid which is trapped within said working spaces acts upon the damping piston 24 to prevent its movement in either direction relative to the cylinder 13.

It will be understood that the arrangement which has been described is given merely by way of example and that various modifications are possible in the construction and arrangement of the parts. Thus it will be seen that the floating piston may be disposed at that end of the cylinder opposite to the piston rod, in which case it would be disc-like instead of annular; the by-pass valve is then preferably modified to open in the opposite direction against the relatively strong force of its closing spring when an excessively powerful tension is applied to the shock absorber.

The particular form of shock absorber described is primarily intended for mounting within a coil spring forming the resilient suspension of a gun carriage, the trapping of the liquid to prevent movement of the shock absorber plunger in the cylinder being used to prevent the suspension from operating when the gun is in action. It is obvious that the shock absorber may be modified for other uses, such as the suspension of road or other vehicles.

Having now particularly described and ascertained the nature of our said invention, and in what manner the same is to be performed, we declare that what we claim is:—

1. A liquid damped shock absorber having a cylinder, a damping piston dividing the interior thereof into two liquid-filled working spaces, damping means in the piston affording a restricted communication between said working spaces, a piston rod extending from the damping piston through an end wall of the cylinder to constitute one of the external attachment means of the device, and a floating piston, mounted slidably in the cylinder, to form a boundary wall for one of said working spaces and so compensate for the variable displacement of the piston rod, characterised by the fact that the damping means in the piston is adjustable from the exterior of the shock absorber by a member extending longitudinally through the piston rod and having operating means accessible from the outside of the shock absorber.

2. A liquid damped shock absorber as claimed in Claim 1, wherein the damping means in the piston includes a constriction the size of which is adjustable by the member extending longitudinally through the piston rod.

the uniform diameter part of the aperture through the valve member, but leaving the valve free to lift. This position is preferably indicated by a resilient arm clamped under the outer fixing nut for the stem, and bent upwardly and inwardly to engage a projecting collar on the cap secured to the end of the rod. The spring loading of the valve member is such that it does not lift under the pressures normally encountered, so that the damping is governed by the relative diameters of the aperture in the valve member, and the metering pin. The valve can, however, open if an exceptionally great compressive force is applied to the shock absorber, to allow a greater passage for the flow of liquid. When the shock absorber is compressed, the plunger stem occupies a greater volume of the space in the cylinder, the liquid displaced being accommodated by compression of the Belleville washers and resultant movement of the floating piston. The Belleville washers also serve to cushion the recoil of the shock absorber when it reaches the end of its normal extension stroke.

By screwing the rod inwardly until its inner end seats in the flared end of the aperture in the valve member, and holds the valve member on to its seat, the passage of liquid from one side of the piston to the other is prevented, and the shock absorber becomes in effect an incompressible strut of fixed length.

The particular form of shock absorber described is primarily intended for mounting within a coil spring forming the resilient suspension of a gun carriage, the tripping of the liquid to prevent movement of the shock absorber plunger in the cylinder being used to prevent the shock absorber from operating when the gun is in action. It is obvious that the shock absorber may be modified for other uses, such as the suspension of road or other vehicles.

Dated this 8th day of January, 1943.
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This invention relates to liquid damped shock absorbers, and has for its primary object to provide a simple and effective shock absorber. Another object is to provide a telescopic shock absorber comprising a plunger adapted to reciprocate in a cylinder in which telescopic movement can readily be prevented, when required, by closing the liquid transfer passages through the plunger.

In a liquid damped shock absorber having a cylinder, a damping piston dividing the interior thereof into two liquid-filled working spaces, damping means in the piston affording a restricted communication between said working spaces, a piston rod extending from the damping piston through an end wall of the cylinder to constitute one of the external attachment means of the device, and a floating piston, mounted slidably in the cylinder, to form a boundary wall for one of said working spaces and so compensate for the variable displacement of the piston rod, the present invention is characterised by the fact that the damping means in the piston is adjustable from the exterior of the shock absorber by a member extending longitudinally through the piston rod and having operating means accessible from the outside of the shock absorber.

Preferably the damping means in the piston includes a constriction the size of which is adjustable by the member extending longitudinally through the piston rod. The adjusting member can comprise a longitudinal rod extending through an axial bore in the piston rod and arranged to be adjusted axially by means of a screw-thread. In the preferred arrangement, the constriction is produced by a pin which is carried by the inner end of the longitudinal rod and is normally disposed within a passage in the damping piston so as to produce in said passage a constriction of narrow annular cross-section for the flow of liquid from one side of the damping piston to the other.

The invention is illustrated by way of example in the accompanying drawing, which is a sectional elevation of a shock absorber installed in conjunction with a suspension spring of the helical compression type.

This suspension spring is indicated at 10 and is arranged to operate between an upper fixing bracket 11 secured to the vehicle frame or body, while the lower part of the spring 10 is housed within a cup-shaped bracket 12 carried by the wheel axle or equivalent.

The shock absorbing unit comprises a cylinder 13, which is closed at its lower end by a cap 14, having an integral spigot 15 serving, in conjunction with a nut 16, to clamp the cylinder 13 to the bracket 12. The upper end of the cylinder 13 is fitted with a cap 17 by means of a screw-thread 18, said cap being formed with a central aperture through which a tubular piston rod 19 is freely slidable, the upper end of said piston rod being screw-threaded at 20 and being provided with nuts 21 and 22 serving to clamp said rod to the upper bracket 11. An inverted cup-shaped dust shield 23 is also clamped by the nut 21 and its skirt portion extends downwards around the cylinder 13 so as to protect the piston rod 19 from dirt, water and other foreign matter.

Formed upon the lower end of the piston rod 19 is a damping piston, having a circumferential groove containing a packing ring 25 so as to enable said piston 24 to have a substantially liquid-tight sliding fit within the cylinder 13. The piston 24 thus divides the interior of the cylinder 13 into two variable volume working spaces, indicated at 26 and 27. Said piston 24 is shaped with a substantially cylindrical recess 28, communicating freely with the working space 26 by way of a plurality of oblique passages 29, while the lower part of said recess is partially closed by an annular seating member 30 screw-threaded in position and provided with a washer 31 so as to produce a liquid-tight joint between the seating member 30 and the piston 24. This seating member has an inwardly directed circumferential flange 32, the upper edge of which is adapted to form a seating for a mushroom-shape by-pass valve member 33, the head portion of which has a frusto-conical face or seating 34. The by-pass valve member 33 is urged against the flange 32 by a relatively strong coiled compression spring 35, taking abutment against the upper surface of the recess 28. The stem portion 36 of the valve member 33 is drilled axially at 37, so producing a passage which communicates between the working spaces 26 and 27. This passage is, however, constricted to provide the requisite damping effect by a pin 38, screw-threaded into the lower end of a longitudinal rod 39 fitting slidably within the tubular piston rod 19. In order to secure a liquid-tight fit between these parts the rod 39 has a circumferential groove adjacent its lower end for the accommodation of a rubber or other resilient packing ring 40.

The pin 38 is arranged to be axially adjusted relative to the valve member 33 and for this purpose the upper end of the rod 39 is fixed to a cup-shaped nut 41, which latter is screw-threaded upon the top part of the piston rod 19 and is provided with a knurled flange 42 to serve as a finger-operated adjustment. Axial adjusting movement of the nut 41 is limited by a pointer 43, which, however, is sufficiently resilient to be deflected outwards when it is desired to remove the nut 41 and rod 39 from the shock absorber.

At the upper part of the cylinder 13 is a floating piston, which is indicated generally at 44, and is arranged to serve as a boundary wall for the variable volume working space 26. The floating piston 44 comprises a washer 45 of resilient material such as rubber, which washer is a tight sliding fit within the cylinder 13 and is provided with metal reinforcing plates 46 and 47, clamped together in spaced relationship by rivetted studs 48. The plate 47 is formed with a tubular extension 49 and this serves as a support for a number of wear-resisting rings 50, having a sliding liquid-tight fit upon the outside of the piston rod 19. Thus the floating piston 44 serves as a liquid-tight packing between the piston rod 19 and the interior of the cylinder 13. Between the upper surface of the floating piston 44 and the interior of the cap 17 is a compression spring 51, conveniently comprising a plurality of dished or Belleville washers 52 arranged alternately so as to produce a W-formation, as seen in radial section. It will, of course, be appreciated that when outward force is exerted by the floating piston 44 the washers 52 are resiliently deformed to a more flattened condition and thus act in the same manner as a coiled compression spring. The uppermost of the washers 52 abuts against a thick annular support washer 53 disposed within the cap 17.

After assembly, the shock absorber is filled with liquid by withdrawing the piston rod 19 to the maximum possible extent from the cylinder 13, thus drawing the damping piston 24 into firm contact with the floating piston 44. The nut 41 is unscrewed from the piston rod 19, the pointer 43 being sprung to one side in order to allow said nut 41 and the rod 39 to be withdrawn completely from the piston rod 19. This leaves the bore of the piston rod 19 free and liquid is poured in through said bore until the interior of the shock absorber is completely full of

liquid. The rod 39 is then replaced and the nut 41 screwed upon the piston rod 19 to approximately the position shown in the drawing. The pin 38 is consequently positioned just within the passage 37 of the by-pass valve 33, thus leaving between said pin and the passage 37 a constriction which in cross-section is in the form of a narrow annulus. Therefore as the bracket 12 tends to move up and down relative to the bracket 11 liquid has to pass to and fro through the constricted passage 37, due to movements of the damping piston 24 relative to the cylinder 13. This, of course, damps the movement and enables smooth riding of the vehicle to be obtained. The degree to which the passage 37 is constricted can be regulated from the outside of the shock absorber by suitably adjusting the postion of the nut 41. Should the bracket 12 receive a severe impulse in an upward direction, the consequent excessive rise in liquid pressure within the working space 27 creates upon the by-pass valve member 33 an upward force which is able to overcome the compression spring 35, so that said by-pass valve is opened and liquid can readily escape from the working space 27 by flowing between the face 34 of the valve member and the seating on the flange 32. Excessively powerful movements of the cylinder 13 in a downward direction merely cause the pressure liquid within the working space 26 to act strongly in an upward direction upon the floating piston 44, thus compressing the spring 51 and so avoiding damage to the shock absorber. The floating piston 44 and spring 51 also serve to accommodate the variations in the pressure of the damping liquid within the cylinder 13 owing to the variable displacement of the piston rod 19, the floating piston 44 rising against the spring 51 as the piston rod 19 moves downwards within the cylinder 13. Moreover, the spring 51 also serves to cushion the recoil of the shock absorber when the damping piston 24 comes into engagement with the floating piston 44 towards the end of a full extension stroke.

In certain circumstances it may be desirable to use the shock absorber as a hydraulic locking device between the brackets 11 and 12, and to produce this effect the nut 41 is screwed downwards upon the piston rod 19 so that the longitudinal rod 39 bears at its lower end against a countersunk frusto-conical surface 54 at the end of the stem 36 of the by-pass valve 33. It will be seen that this not only closes the passage 37 completely but also forcibly holds the by-pass valve member 33 in seating engagement with the flange 32; therefore all communication between the working spaces 26 and 27 is cut off and the liquid which is trapped within said working spaces acts upon the damping piston 24 to prevent its movement in either direction relative to the cylinder 13.

It will be understood that the arrangement which has been described is given merely by way of example and that various modifications are possible in the construction and arrangement of the parts. Thus it will be seen that the floating piston may be disposed at that end of the cylinder opposite to the piston rod, in which case it would be disc-like instead of annular; the by-pass valve is then preferably modified to open in the opposite direction against the relatively strong force of its closing spring when an excessively powerful tension is applied to the shock absorber.

The particular form of shock absorber described is primarily intended for mounting within a coil spring forming the resilient suspension of a gun carriage, the trapping of the liquid to prevent movement of the shock absorber plunger in the cylinder being used to prevent the suspension from operating when the gun is in action. It is obvious that the shock absorber may be modified for other uses, such as the suspension of road or other vehicles.

Having now particularly described and ascertained the nature of our said invention, and in what manner the same is to be performed, we declare that what we claim is:—

1. A liquid damped shock absorber having a cylinder, a damping piston dividing the interior thereof into two liquid-filled working spaces, damping means in the piston affording a restricted communication between said working spaces, a piston rod extending from the damping piston through an end wall of the cylinder to constitute one of the external attachment means of the device, and a floating piston, mounted slidably in the cylinder, to form a boundary wall for one of said working spaces and so compensate for the variable displacement of the piston rod, characterised by the fact that the damping means in the piston is adjustable from the exterior of the shock absorber by a member extending longitudinally through the piston rod and having operating means accessible from the outside of the shock absorber.

2. A liquid damped shock absorber as claimed in Claim 1, wherein the damping means in the piston includes a constriction the size of which is adjustable by the member extending longitudinally through the piston rod.

3. A liquid damped shock absorber as claimed in Claim 1 or 2, wherein the adjusting member comprises a longitudinal rod extending through an axial bore in the piston rod and arranged to be adjusted axially by means of a screw-thread.

4. A liquid damped shock absorber as claimed in Claim 3, wherein the longitudinal rod is provided at its outer end with a nut which engages a screw-thread formed upon the outside of the piston rod.

5. A liquid damped shock absorber as claimed in Claim 3 or 4, wherein the longitudinal rod is arranged to be withdrawn from the piston rod while the shock absorber is fully assembled, so as to provide a passage for the insertion of damping liquid.

6. A liquid damped shock absorber as claimed in Claims 2 and 3, wherein the constriction is produce by a pin which is carried by the inner end of the longitudinal rod and is normally disposed within a passage in the dampnng piston so as to produce in said passage a constriction of narrow annular cross-section for the flow of liquid from one side of the damping piston to the other.

7. A liquid damped shock absorber as claimed in any preceding claims, wherein the damping piston is provided with a by-pass valve device affording communication from one side of the damping piston to the other, said valve device being held closed by a relatively strong spring so that it only opens when an exceptionally large force is imparted to the shock absorber and creates liquid pressure acting in the valve-opening direction.

8. A liquid damped shock absorber as claimed in Claim 7, wherein the longitudinal member is adjustable from the exterior of the shock absorber so that its inner part holds the by-pass valve in its closed position, thereby rendering the by-pass valve inoperative.

9. A liquid damped shock absorber as claimed in Claims 6 and 8, wherein movement of the longitudinal member or rod to its valve-closing position also closes the constricted passage through the damping piston and causes the latter to be hydraulically locked within the cylinder.

10. A liquid damped shock absorber as claimed in Claim 9, wherein the by-pass valve comprises a mushroom valve member having a frusto-conical face upon the "upper" surface of its head to engage with an annular seating on the damping piston, a bore extending through its stem to form the constricted passage, and a countersunk frusto-conical seating at the end of the stem arranged to be closed in a substantially liquid-tight manner by the end of the longitudinal member or rod when the latter is moved to its hydraulic locking position.

11. A liquid damped shock absorber as claimed in any preceding claim, having a spring urging the floating piston in a direction tending to reduce the combined volume of said working spaces, wherein said spring is of the type comprising a plurality of dished annular washers fitted together in W-formation as seen in radial section.

12. A liquid damped shock absorber as claimed in any preceding claim, wherein the floating piston comprises a circular disc or annulus of resilient material, having a stiffening plate on each side, the resilient material being arranged to rub directly against the interior of the cylinder to form a liquid-tight seal.

13. A liquid damped shock absorber as claimed in Claim 12, wherein one or more sealing rings are interposed between the piston rod and the resilient material of the floating piston to form a wear-resistant surface against which the piston rod slides.

14. The improved liquid-damped shock absorber, substantially as described with reference to the accompanying drawing.

Dated this 7th day of January, 1944.
For the Applicants:
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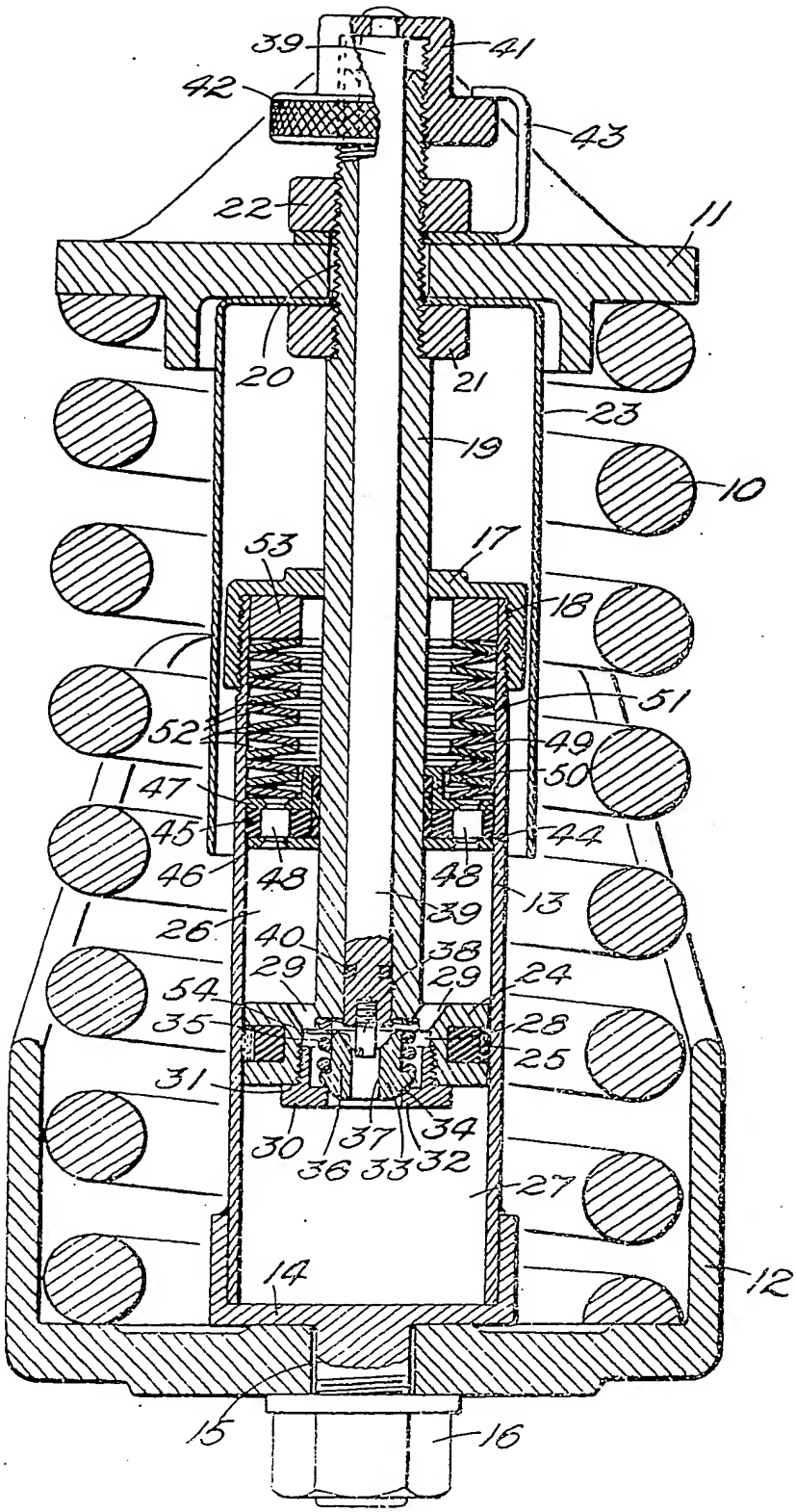
Chartered Patent Agents,
29, Southampton Buildings,
Chancery Lane, London, W.C.2.

Leamington Spa: Printed for His Majesty's Stationery Office, by the Courier Press.—1944.



[This Drawing is a reproduction of the Original on a reduced scale.]

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